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#2 Lacustrine Clay.

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LACUSTRINE CLAY

Of the

EDMONTON REGION

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The following paper Submitted by the result of some  
one hundred and twenty-five hours of laboratory  
E. L. HILL, B.A.,  
work spent in making physical and chemical examination  
In connection with course prescribed for  
region, and tests of local clay of earlier  
DEGREE OF MASTER OF SCIENCE.  
geological age.

UNIVERSITY OF ALBERTA.

Strathcona,

May, 1911.

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## Economic Aspect

The commercial importance of clay may be readily understood from the value of the products. According to the Canada Year Book compiled by the Dominion Government Statistics Department, the total value of clay products for 1906, including brick, tile and pottery, amounted to \$4,774,398. The

### Prefatory Note.

The following pages contain the result of some one hundred and twenty-five hours of laboratory work spent in making physical and chemical examination of the typical lacustrine clay of the Edmonton region, and tests of local clay of earlier geological age.

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The commercial importance of clay may be readily understood from the value of the products. According to the Canada Year Book compiled by the Dominion Government Statistics Department, the total value of clay products in the Dominion, for 1906, including brick, tile and pottery, amounted to \$4,774,305. The wages paid to the 6154 wage-earners employed amounted to \$1,803,287. A noteworthy increase in the value of clay products is evidenced by the fact that for 1909 the value of bricks alone was \$4,200,000.

The value of clay products in the United States for 1907 was \$158,942,369.

Between the Saskatchewan and Athabasca Rivers. Northwest the lacustrine surface is distinct until it becomes obscured by morainic material near Onoway on the main line of the C.N.R.

Cutting across this plain is the Edmonton district. The Saskatchewan exposes immense deposits of typical boulder-clay found beneath the lacustrine surface deposits. The boulder-clay gives distinct

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## Lacustrine Clay.

The greater portion of the surface of the rather well-defined plain around Edmonton consists of old lake deposits, silt and clay. These deposits characterize nearly the whole of the old lake bottom followed by the Calgary and Edmonton Railway. North of Edmonton the lake bottom exposure extends west over the Stony Plain district, east to the glacial deposits of the Beaver Hills, and north for some forty or fifty miles to the sand-ridges characteristic of the watershed between the Saskatchewan and Athabasca Rivers. Northwest the lacustrine surface is distinct until it becomes obscured by morainic material near Onoway on the main line of the C.N.R.

Cutting across this plain in the Edmonton district, the Saskatchewan exposes immense deposits of typical boulder-clay found beneath the lacustrine surface deposits. The boulder-clay gives distinct

## EDMONTON PLAIN

The greater portion of the surface of the plain is well-defined plain around Edmonton consists of old lake deposits, silt and clay. These deposits extend eastward nearly the whole of the old lake bottom followed by the Calgary and Edmonton Railway. North of Edmonton the lake bottom exposure extends west over the Stoney Plain district, east to the glacial deposits of the Beaver Hills, and north for some forty or fifty miles to the sand-ridges characteristic of the watershed between the Saskatchewan and Assiniboine Rivers. Northwest the lacustrine surface is divided until it becomes composed by moraine material near Onaway on the main line of the C.N.R.

Cutting across this plain in the Edmonton district the Saskatchewan exposes immense deposits of glacial boulder-clay found beneath the lacustrine surface. The boulder-clay is composed of



evidence of the Kewatin ice-sheet, with possible evidence of a previous Cordilleran glaciation.

The retreat of the final ice-sheet with formation of glacial lakes probably accounts for these extensive deposits of lacustrine clay of Pleistocene age.

The Saskatchewan and its tributaries by erosion of the boulder-clay contained in the banks, carry down great quantities of fine material much of which goes to form clay deposits of the flood-plain variety. These deposits partake of the yellow color of the boulder-clay.

An important local deposit of compact clay, decidedly different in character from the widespread lacustrine clay, occurs within the limits of the City of Strathcona. This deposit underlies several feet of boulder-clay and would appear to be either interglacial or the product of the possible Cordilleran glaciation. Contrasted with the typical clay it presents the following features :

Dark grey in color ; very compact; fracture rough ; brownish-grey on strong ignition; loss on

...the ... of the ...

The variety of stones and concretions and the  
... of the ...  
... is especially ...  
... the ... and ...  
... .

... and ...  
... for the ...  
... has been ...  
... at ...  
... a ...  
... of the ...  
... the clay is nearly everywhere readily  
... .

... as the writer is aware no serious effort  
has been made to utilize locally the clay for  
making "ballast" for road-building. In some local-  
ities gravel and stone are almost unobtainable.  
It would appear that the use of clay ballast  
might be a ready means of overcoming some of the

difficulties that beset the construction of roads without gravel or stone.

It should be stated that at various points in the region in which the lacustrine deposits occur, the presence of large amounts of soluble alkaline salts render the clay unfit for making face brick. The occurrence of objectionable white efflorescence would be certain. It is very doubtful whether thorough weathering would remove enough of this "alkali" by leaching, to avoid the development of efflorescence. The use of coal for "burning" is liable to lead to formation of sulphates which will produce the white efflorescence known as "wall-white"

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through weathering could remove enough of this  
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of efflorescence. The use of coal for heating is  
likely to lead to formation of sulphates which will  
increase the efflorescence known as "well-

water



## Physical Analysis.

The sample used was taken from a deposit near Fort Saskatchewan. It is yellowish grey in color, has an even, angular fracture and readily crushes to an almost impalpable powder.

Experiments were made to determine the relative fineness of the clay. A sample of 100 grams was taken. This was boiled with water and treated to cause disintegration. After repeated agitations with relatively large volumes of water, the following separation was made :

Precipitated in 1 minute	- - - -	1.10
"           " 3 minutes	- - - -	3.96
"           " 10       "	- - -	7.20
"           " 60       "	- - - -	74.70
in suspension after 60 minutes	- - -	13.58
		<hr/> 100.54

Microscopic examination revealed the fact that the sample had been separated into fairly defined "aggregates" which were strongly resistant to the attempts made to disintegrate the sample.

# Physical Properties

The sample used was taken from a deposit near Fort Saskatchewan. It is yellowish grey in color, has a very fine, granular texture and readily breaks to an almost impalpable powder.

Experiments were made to determine the relative fineness of the clay. A sample of 100 grams was placed in a 100 cc. beaker and filled with water. After dispersion, after several minutes, the relative large volume of water, the following

separation was made :

Precipitated in 1 minute	- - - -	1.10
" " 3 minutes	- - - -	2.00
" " 10 "	- - - -	3.20
" " 60 "	- - - -	74.70
in suspension after 60 minutes	- - - -	17.38

100.00

Microscopic examination revealed the fact that the sample had been separated into fairly defined "aggregates" which were strongly resistant to the attempts made to disintegrate the sample.

Less than one per cent consisted of sand granules varying from .0332 mm. to .1328 mm. in diameter. The remainder of the sample consisted of particles of an average diameter of .0010 mm., with .0006mm. as a minimum and .0027 mm. as a maximum. The extreme fineness and uniformity of the sample are strikingly characteristic.

This clay exhibits a good degree of plasticity. While no simple theory seems adequate to explain the cause of plasticity in clays, the remarkable fineness of the clay under discussion may be assigned very properly as one of the causes of its great plasticity.

On ignition air-dried samples were found to lose 9.55 per cent. Of this 3.50 per cent was moisture capable of being expelled by heating for several hours to a point slightly above the boiling point of water.

The ignited sample became reddish-brown as might have been expected from the presence of nearly six per cent. of ferric oxide.

The fineness of the clay would ~~make~~ it possible

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nature of plasticity in clays, the remarkable thin-  
ness of the clay under consideration may be explained  
very properly as one of the causes of its great  
plasticity.  
On further air-dried samples were found to have  
a loss of weight of 1.50 per cent and indicate  
evidence of being related to heating for several  
hours at a point slightly above the boiling point  
of water.  
The ignited sample became reddish-brown as  
might have been expected from the presence of nearly  
six per cent. of ferric oxide.  
The fineness of the clay would make it possible



to use the ignited material as a pigment. Rubbed up with oil it presents a sienna-like appearance.

The weight of water absorbed by 100 grams of clay was found to be 63.80 grams. With the 3.50 per cent. in an air-dried sample, the total absorptive power of 100 grams of moisture-free clay is thus 67.30 grams. Or the amount of water in a saturated sample is slightly over 40 per cent.

When the saturated mass was allowed to air-dry, it became hard enough to withstand very rough handling.

in use the liquid material as a solvent. Indeed,  
the fill oil it represents a flame-like substance.  
The weight of water absorbed by 100 grams of  
clay was found to be 67.80 grams. With the 2.50  
per cent. in an air-dried sample, the total ab-  
sorption power of 100 grams of water-saturated clay  
is thus 67.80 grams. If the amount of water in a  
saturated sample is slightly over 40 per cent.,  
then the saturated mass was allowed to dry,  
it became hard enough to withstand very rough handling.

## Chemical Analysis.

Formed largely of material eroded from the characteristic Laurentian rocks, The clay exhibits a composition consistent with such origin.

Undoubtedly a large portion of the silicon is present as the dioxide derived from the quartz of gneissoid rocks.

The aluminum is present in almost the same proportion as in orthoclase.

Magnesium is traceable to such minerals as muscovite, hornblende and pyroxene.

Fragments of these minerals have been detected in the Leda clays of Canada - of one of which an analysis is appended.

For the sake of comparison there are also appended analyses of a number of United States clays.

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Undoubtedly a large portion of the silicon is  
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The analysis of these minerals have been determined  
in the beds of Canada - of one of which an  
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For the sake of comparison there are also ap-  
pended analyses of a number of United States  
samples.



# Analysis of Edmonton Lacustrine Clay.

Silica - - - - - - - -59.60

Alumina - - - - - - - 17.96

Ferric Oxide - - - - - 5.94

Magnesia - - - - - - - 1.86

Lime - - - - - - - - 2.60

Moisture - - - - - - - 3.50

(Additional) Loss on ignition - 6.05

A comparison of these results with various analyses shows this clay to resemble chemically good brick clays.

The following figures are given by Willet G. Miller as the percentage composition of an ordinary brick-clay.

# Analysis of Edmonton Lacustrine Clay.

Water -	11.15
Alumina -	17.75
Calcium oxide -	1.01
Magnesia -	4.86
Lime -	2.80
Iron oxide -	1.10
(Additional) Loss on ignition -	8.03

A comparison of these results with various analyses made this clay is presented herewith:

Good brick clays.

The following figures are given by Miller as the percentage composition of an ordinary brick-clay.

Silica - - - - -	-59.96
Alumina - - - - -	-19.58
Ferric Oxide - - - - -	5.86
Lime - - - - -	2.62
Magnesia - - - - -	2.30
Potash - - - - -	2.57
Soda - - - - -	2.48
Sulphur trioxide - - -	.23
Water, Carbon dioxide, &c	5.00

The close resemblance is apparent.

It should be noted that chemical analysis alone does not give a true estimate of the economic value of a clay. It is necessary to take into consideration the physical side of the question.





## Fire-Clays.

The term fire-clay is loosely employed to designate clay of high fusing-point, though sometimes wrongly applied to material occurring in situations similar to those in which true fire-clay is found. Fire-clay is often found underlying coal-beds, though no thoroughly satisfactory explanation of such occurrence has been offered. Frequently the clays and shales underlying coal-seams are non-refractory. Extensive beds of refractory clay are found in the Atlantic and Gulf coastal plains non-associated with coal-beds.

A good fire-clay must be highly refractory, hence its composition should show low percentages of such fluxing materials as ferric oxide, lime, magnesia and alkalies. The late Prof. E.J. Chapman was accustomed to condemn a sample if it became tawny under ignition. Certain fire-clays seem to have excellent heat-resisting power, though iron content is appreciable.

The following are analyses taken from Reports of the N.J. Geol. Survey, and Missouri Geol. Survey respectively.

The term "lignite" is loosely employed in describing  
 any of these carbonaceous, brown, woody materials  
 applied to material occurring in strata which is  
 to them in which the lignite is found. Lignite  
 is often found underlying coal-beds, though no thor-  
 oughly satisfactory explanation of such occurrence  
 has been offered. Presumably the lignite and higher  
 carbonized coal-seams are non-retrograde. Lignite  
 beds of retrograde lignite are found in the Atlantic and  
 Gulf coastal plain non-associated with coal-seams.  
 A good lignite must be highly refractory, hence  
 its conversion should have the advantage of being  
 (using suitable as for the existing lignite, which  
 may explain the fact that the lignite was not  
 to be condensed a sample if it became fairly under  
 (lignite, carbonaceous lignite) to have retained  
 heat-retaining power, though even contact is essential  
 The following are analyses taken from reports of  
 the U. S. Geological Survey, and of the U. S. Bureau of  
 Mines:

New Jersey No.1 Fire-Clay.		St.Louis Fire-Clay	
Silica	- - - - - 51.56	- - - - -	59.36
Alumina	- - - - - 33.13	- - - - -	23.26
Ferric Oxide	- - .78	- - - - -	3.06
Lime	- - - - - tr.	- - - - -	.65
Magnesia	- - - - - tr.	- - - - -	.42
Potash	- - - - - tr. )	) - - - - -	.63
Soda	- - - - - tr. )		
Titanic Acid	- - -1.91	- - - - -	-1.01
Water	)	- - - - -	10.20
	) - - - 12.50		
Moisture	)	- - - - -	2.74

The high value of fire-clay makes it desirable that some systematic effort should be made to discover deposits in Alberta. They are widely distributed in the United States both geologically and geographically.





Analysis of a St. Lawrence Pleistocene (Leda) Clay.

Silica - - - - - 52.95

Alumina & Ferric Oxide 27.30

Lime - - - - - 5.32

Magnesia - - - - - 2.62

Potash - - - - - 1.26

Soda - - - - - 2.06

Phosphoric Acid - .74

Carbonic Acid - - - 3.25

Water - - - - - 5.50

( Geol. Survey of Canada, 1863 ).

Analysis of a typical sample (see table)

Silica	58.95
Alumina & Ferric Oxide	27.50
Lime	1.75
Hydroxide	2.85
Water	1.70
Soda	2.68
Phosphoric Acid	.74
Carbonic Acid	2.75
Loss	1.80

(Geol. Survey of Canada, 1887).

## Wisconsin Pleistocene Clay.

Used for common brick. Considered of little value for any other purpose.

Silica - - - - -	48.39
Alumina - - - - -	12.50
Ferric Oxide - -	5.40
Lime - - - - -	10.88
Magnesia - - - - -	4.82
Potash - - - - -	3.90
Soda - - - - -	.68
Loss on ignition	13.02
Titanic Acid - -	.43

# Wisconsin Bluestone Clay.

Used for common brick. Considered of little

value for any other purpose.

Water - - - - - 10.50

Alumina - - - - - 18.50

Ferric Oxide - - - - - 5.40

Lime - - - - - 10.33

Magnesia - - - - - 4.82

Potash - - - - - 3.90

Soda - - - - - .68

Loss on ignition - 15.02

Hydrochloric Acid - - 47



North Dakota Pleistocene Clay.

This is a typical calcareous clay regarded as of value for little else than common brick.

Silica - - - - -51.27

Alumina - - - - 9.33

Ferric Oxide - - 3.52

Lime - - - - -11.15

Magnesia - - - 2.31

Soda - - - - - 2.08

Potash - - - - - .50

# Fourth Decade Classification List

This is a typical reference size determined as  
of value for little else than common factor.

Office	-	-	-	-	-	-	21.25
Aluminum	-	-	-	-	-	-	4.33
Barium Oxide	-	-	-	-	-	-	2.62
Time	-	-	-	-	-	-	11.18
Magnesium	-	-	-	-	-	-	8.31
Gold	-	-	-	-	-	-	2.68
Copper	-	-	-	-	-	-	2.50

Sewer- Pipe Clay, Red Wing, Minnesota.

Much of the sewer- pipe used in Alberta is made from this.

Silica	- - - - -	69.84
Alumina	- - - - -	23.07
Ferric Oxide	- -	.48
Lime	- - - - -	.11
Magnesia	- - - - -	.14
Potash)		
Soda )	- - - - -	trace
Water	- - - - -	6.35

Sewer-Pipe Clay, Canton, O.

Silica	- - - - -	57.10
Alumina	- - - - -	21.29
Ferric Oxide	- -	7.31
Lime	- - - - -	.29
Magnesia	- - - - -	1.53
Potash	- - - - -	3.44
Soda	- - - - -	.61
Water	- - - - -	-7.30

new-type clay, Red Wing, Minnesota.

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